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Bioproducts development by Canadian biotechnology firms: findings from the 2001 Biotechnology Use and Development Survey

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This paper represents the views of the author and does not necessarily reflect the opinions of Statistics Canada.



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The science and innovation information program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors:** are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities:** include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages:** are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes:** are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts:** are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical**

Information System, Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at <http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193>.

Table of Contents

Executive Summary	7
Highlights	7
Introduction	9
II Data	10
III Bioproduct Development: Main Indicators and Other Firm Characteristics.....	12
3.1 Bioproduct Firms Distribution.....	12
3.2 Total Employment, Revenues, R&D Expenditures, Export, and Import Revenues.....	13
3.3 Other Bioproduct Firms' Characteristics	14
IV What Types of Bioproducts are Being Developed?	15
4.1 Number of Bioproducts being developed	15
4.2 Types of Bioproducts.....	16
V Which Sectors are Involved in Developing Bioproducts?.....	17
VI Bioproduct Employment, Revenues, R&D Expenditures, Export, and Import Revenues	18
VII Limits of the study	19
References	21
How to order catalogued publications	22
Appendix I	29
Appendix II.....	32

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Bioproducts development by Canadian biotechnology firms: findings from the 2001 biotechnology use and development survey

Executive Summary

This paper used data from the 2001 Biotechnology Use and Development Survey (BUDS) to look into bioproduct development using biotechnologies. Results show that the development of bioproducts has become an intrinsic part of Canadian biotechnology firms' activities.

Bioproducts are also developed by firms not engaged in biotechnology, but this paper offer no information on the activities of these firms.

In 2001, 133 biotechnology firms were involved in making or developing bioproducts. They employed 39,140 people, earned \$15.3 billion in revenues and spent a total of \$598 million on R&D. They earned \$564 million in export revenues and imported good and services worth \$64 million. They had a portfolio of 805 bioproducts.

Highlights

- In 2001, there were 133 firms that used biotechnologies to develop bioproducts;
- All firm size categories were involved in bioproduct development process. However, small firms with 50 employees or fewer¹ stood as the largest group;
- Three provinces, Quebec, Ontario and British Columbia are home to 81% of all the firms. However, with 35% of all the firms, Quebec is home to the largest number of firms.
- 62% of all the firms had a product being either approved, in production, or on the market. Thus, they were either already reaping the benefits from their investments in bioproducts or were about to do so;
- Large firms with over 150 employees accounted for the lion's share of employment, revenues and export revenues;
- Small firms accounted for the most investment in R&D relative to their revenues. Comparatively, medium-sized firms with employees numbering 51 to 150 were the most involved in import activities;
- Bioproduct development is principally in the hands of young private Canadian "home-grown" firms, a third of which were spun-off from various sources;

¹ Medium-sized firms have 51 to 150 employees and large firms have over 150 employees. The choice of these size thresholds came about in the 1997 Biotechnology Firm Survey. Statistics Canada wanted to retain some measure of comparability with existing sources of biotechnology data in Canada. Subsequently, to enable comparison of the estimates from one survey to the other, these thresholds were retained and continue to be used.

- In total 805 bioproducts were being made or developed; 588 of these were at the approval/in production/ on the market stage, implying that they were bringing in some revenues or were about to enter market;
- Bioprocessing based bioproducts development involved the largest number of firms and accounted for the largest number of products as well;
- Bioproduct development was found to be a cross-sectoral activity as firms from several sectors take part and the development of bioproducts intended for use in any given sector was not limited to firms active in that sector alone.

Bioproducts Development by Biotechnology Firms: Findings from the 2001 Biotechnology Use and Development Survey

Introduction

On the roadmap towards a sustainable economy, the use of biotechnologies or renewable resources has led to the development of new products and processes. This paper is an attempt to provide some information on biotechnology firms engaged in the development of bioproducts. The concept of bioproduct does not yet have any agreed upon definition. It more or less refers to new products "developed from living organisms and their constituent parts that may replace or augment products derived from non-renewable resources" (Agriculture and Agri-Food Canada, 2003). As more bioproducts enter the economy, they may help to achieve Kyoto targets and to preserve non-renewable resources

The current paper is based on data from the 2001 Biotechnology Use and Development Survey. It is intended to report on some findings as they relate to the development of bioproducts by Canadian companies. Its main goal is to contribute to the understanding of the extent of bioproduct development activities in Canada and to provide policy makers with information that is relevant to policy making. To this end, it tries to answer a number of questions. For example, in which sectors do we find firms engaged in bioproduct development? How many people do they employ? How much revenue do they earn and how much do they spend on R&D? Other relevant questions are the types of bioproducts being developed as well as the sectors that are actively involved in developing them.

The organization of the paper is as follows: Section 2 presents the data used; Section 3 looks into the main characteristics of bioproduct firms as they relate to employment, revenues, R&D expenditures, import and export revenues; Sections 4 and 5 focus on the types of bioproducts and the sectors involved, respectively; Section 6 focuses on a group of firms that are exclusively involved in bioproduct development; and, Section 7 highlights the limits of the study and serves as a conclusion.

Note to the readers

Defining a bioproduct

To date, there is no agreed upon definition of bioproduct. In the Agricultural Policy Framework (APF), Agriculture and Agri-Food Canada defines a bioproduct as *"a product from living organisms and their constituent parts that may replace or augment products derived from non-renewable resources"*. In this paper and in the 2001 Biotechnology Use and Development Survey (BUDS), a bioproduct is defined as *"a commercial or industrial product (other than food and feed) made with biological or renewable domestic agricultural (plant, animal), marine or forestry materials, such as bio-energy (heating and electricity), bio-fuels (ethanol and bio-diesel), bio-chemicals, fiberboard, textiles and bio-plastic, other"*.

Biotechnology Use and Development Survey – 2001²

The 2001 BUDS was conducted in two phases. In phase 1, in addition to the question on the use and development of biotechnologies, respondents were also asked whether or not they were making or developing any bioproduct. One hundred (100) firms also reported being involved in the use and the development of biotechnology. During the second phase i.e. the full survey, 57 of these 100 firms were actually developing or making bioproducts. An additional 76 firms that did not enter any answer to the bioproduct question of phase 1 or which answered "NO" were making bioproducts. They were added to the 57 firms from phase 1 to form the population of 133 bioproduct firms used in this study.

What the figures in this study do not say

Mindful of the above, readers should note that the 2001 BUDS was a biotechnology survey and the database does not provide any specific information on such indicators as the personnel engaged specifically in the development of bioproducts, revenues from bioproduct sales, bioproduct R&D expenditures, bioproduct export and import revenues. Figures presented here refer to total employment, total revenues, total R&D expenditures, and total export and import revenues as well. Consequently, they should not be interpreted as resulting solely from the bioproduct development activities of these firms. Furthermore, given the results from phase 1, the 133 biotechnology firms in this study are a subset of the total number of firms that may be involved in developing or making bioproducts in Canada.

II Data

At the request of Agriculture and Agri-Food Canada, a question on the development of bioproducts was included in the first phase of the 2001 Biotechnology Use and Development Survey, BUDS – 2001 (Appendix 1). Respondent firms were asked to answer the following question: *Does your firm currently make or develop a bioproduct?*, "YES" or "NO". In that survey, a bioproduct was defined as *"a commercial or industrial product (other than food and feed) made with biological or renewable domestic agricultural (plant, animal), marine or*

² For more information on the 2001 BUDS, see Traoré (2003), McNiven, Raoub and Traoré (2003).

forestry materials, such as bio-energy (heating and electricity), bio-fuels (ethanol and bio-diesel), bio-chemicals, fiberboard, textiles and bio-plastic, other". The purpose of this question was to identify potential Canadian firms involved in making or developing bioproducts. One hundred (100) of these firms had activities overlapping with biotechnology. These were surveyed in the second phase of the 2001 BUDS questionnaire (Appendix 2). Cognitive interviews during the testing of the first phase of the 2001 BUDS questionnaire showed that not all the respondents had the same definition of a bioproduct. This called for a cross-checking of the answers to the bioproduct question. This was done by selecting a series of fields, shown in Table 1, where the making and the development of bioproducts was probable. This investigation revealed two things. First, 57 of the 100 firms from phase 1 were consistent in that they were developing or making at least one bioproduct. Seventy six (76) other firms that did not enter any answer to the bioproduct question of phase 1 or said "NO" to that question, were in fact developing a bioproduct³. Thus, the final population includes 133 firms, i.e. 57 firms who answered "YES" to the bioproduct question in phase 1 and had a bioproduct in the selected fields; 76 firms which either did not enter any answer to the bioproduct question of phase 1 but had at least one bioproduct.

Table 1: Selected Bioproduct Fields, 2001

Fields	Examples
<i>Non-food Agriculture</i>	Fuels, lubricants, commodity and fine chemical feedstocks, cosmetics
<i>Energy</i>	Microbiologically enhanced petroleum recovery, industrial bioprocessing, biodesulpharization
<i>Mining</i>	Microbiologically enhanced mineral recovery, industrial bioprocessing, biodesulpharization
<i>Forest Products</i>	Biopulping, biobleaching, biopesticides, tree biotechnology, industrial bioprocessing
<i>Air</i>	Bioremediation, diagnostics, biofiltration, phytoremediation
<i>Water</i>	Bioremediation, diagnostics, biofiltration, phytoremediation
<i>Soil</i>	Bioremediation, diagnostics, biofiltration, phytoremediation
<i>Aquaculture</i>	Fish health, broodstock genetics, bioextraction
<i>Bioprocessing</i>	Using enzymes and bacteria culture

Source: Statistics Canada, BUDS 2001

³ Further investigation into the remaining 43 firms from phase 1 was done by telephone calls to their offices and use of secondary sources such as the 2002 Canadian Biotechnology Directory, the 2001 Pharma, BioPharma, and Neutraceuticals directory, and the 2001 Diagnostics Canada directory, all maintained by Contact Canada. This process could not unmistakably establish whether or not these firms were developing any bioproduct. They were subsequently dropped from the set of firms used in this study

III Bioproduct Development: Main Indicators and Other Firm Characteristics

3.1 Bioproduct Firms Distribution

As indicated in Table 2, all firm categories are involved in developing bioproducts. However, small firms with 50 employees or fewer constituted the largest group: 69% of the 133 bioproduct firms. Comparatively, medium-sized firms with employees numbering 51 to 150, and large firms with over 150 employees, accounted for 14 and 17%, respectively. Thus, bioproduct development is concentrated in the small biotechnology firms.

Firms from all provinces are involved in developing bioproducts. The largest concentration is however found in Quebec, 46 out of 133, or about 35%. Ontario and British Columbia follow with 34 and 28 firms, respectively. The Prairies have 17 firms, and the Atlantic provinces, 8 (Table 2). Thus together, Quebec, Ontario and British Columbia are home to 81% of bioproduct firms, with Quebec leading the way.

Accounting only for bioproducts, 83 firms of the 133 were at the approval/on market/in production stage, 27 were at the R&D stage, and 23 had products at the proof of product/product development stage (Table 2)⁴.

Table 2: Distribution of Bioproduct Firms by Size, Province, and Stage of Development, 2001

A) Firm Size	Number of Firms
Small firms (50 and fewer employees)	92
Medium firms (51 to 150 employees)	19
Large firms (Over 150 employees)	22
Total	133
B) Province	
British Columbia	34
Prairies	17
Ontario	28
Quebec	46
Atlantic	8
Total	133
C) Development Stage^(a)	
R&D	27
Proof of concept/product development	23
Approval/on market/in production	83
Total	133

Source: Statistics Canada, BUDS 2001

⁴ In this paper, we focus only on bioproduct development. Consequently, the classification of firms according to the development stage is based solely on the bioproducts (Table 1)

3.2 Total Employment, Revenues, R&D Expenditures, Export, and Import Revenues

Figures in Table 3 show that in 2001, bioproduct firms were employing 39,140 people, they earned \$15.3 billion in revenues and spent a total of \$598 million on R&D. Fifty two (52) of them exported goods and services for a total export revenues of \$564 million. Eight imported good and services worth \$64 million.

The distribution of employment by firm size shows that small firms accounted for 1,136 employees or 3% of total employment, medium-sized firms had 1,669 employees, and large firms employed 36,335 people or 93% of all employees. Firms in Quebec were employing 17,770 people. Comparatively, British Columbia and Ontario had 13,666 employees and 2,118 employees, respectively. Bioproduct firms in the Atlantic provinces had 4,795 employees, more than double employment by firms in Ontario. Firms in the Prairies lied behind firms in other provinces with 791 employees. These figures suggest that in contrast to the Atlantic region, bioproduct development in Ontario is mostly dominated by small and medium-sized firms. All firm size categories are actively involved in Quebec and British Columbia.

Firm size distribution of revenues shows that in 2001, small firms earned \$125 million, as compared to \$371 million for medium-sized firms and \$14.8 billion for large firms. When these figures are compared to revenues, proportionately, small firms spent more on R&D, 117%, than medium-sized firms, 25%, and large firms, 2%. Provincial comparison shows that Quebec's firms earned over \$7 billion, those in British Columbia, \$6.6 billion, those in Ontario, \$572 million. Firms in the Prairies had about \$99 million in revenues. Those in the Atlantic provinces earned \$732 million, more than firms in both Ontario and the Prairies.

In 2001, small firms involved in developing bioproducts spent \$146 million on R&D, medium-sized, \$93 million, and large firms \$359 million. Firms in British Columbia outspent firms in other provinces with a total R&D expenditures of \$287 million, followed by Quebec at \$188 million, Ontario at \$84 million, the Prairies at \$37 million, and the Atlantic provinces at \$2 million.

Of the \$564 million export revenues, small firms accounted for nearly 7% or \$37 million, medium-sized firms, 13% or \$73 million, and large firms, 80% or \$454 million. Firms in Quebec were the most export intensive with \$453 million in export revenues. Ontario was a distant second with \$53 million, followed by the Prairies, with \$46 million, and the Atlantic provinces with half of a million.

Of the 8 bioproduct firms involved in importing goods and services, 4 were medium-sized firms and the remaining four were either small or large firms. Only firms in Ontario and Quebec composed this group. Imports by Ontario's firms amounted to \$33 million as compared to \$31 million in Quebec.

Table 3: Total Employment, Revenues, R&D Expenditures, Export and Import Revenues by Firm Size and Province, 2001

	Total employment	Total revenues (\$000,000)	Total R&D expenditures (\$000,000)	Total export (\$000,000)	Total import (\$000,000)
A) Firm Size					
Small firms (50 and fewer employees)	1,136 (92)	125 (92)	146 (92)	37 (37)	.113 (x)
Medium firms (51 to 150 employees)	1,669 (19)	371 (19)	93 (19)	73 (7)	63 (4)
Large firms (Over 150 employees)	36,335 (22)	14,821 (22)	359 (22)	454 (8)	.511 (x)
Total	39,140 (133)	15,317 (133)	598 (133)	564 (52)	64(8)
B) Province					
British Columbia	13,666 (34)	6,587(34)	287 (34)	8 (13)	0
Prairies	791 (17)	99 (17)	37 (17)	46 (x)	0
Ontario	2,118 (28)	572 (28)	84 (28)	53 (15)	33 (x)
Quebec	17,770 (46)	7,327 (46)	188 (46)	456 (15)	31 (x)
Atlantic	4,795 (8)	732 (8)	2 (8)	.5 (x)	0
Total	39,140 (133)	15,317 (133)	598 (133)	564 (52)	64 (8)

Source: Statistics Canada, BUDS 2001

Notes:

1) The number of firms is in parentheses;

2) Due to rounding, sum of figures in the cells may differ from total

3) x: suppressed to meet confidentiality requirements;

3.3 Other Bioproduct Firms' Characteristics

As shown in Table 4, 19% or 25 of the 133 firms were publicly traded. Comparatively, only 6% or 8 firms were subsidiaries of multinational firms. Thirty five per cent (35%) or 37 firms were spin-offs. In general, bioproduct firms were young, no more than 17 years on average.

Thus, in 2001, bioproduct development was principally in the hands of young private Canadian "home-grown" firms, over a third of which were spun-off from various sources.

Table 4: Other Characteristics of Bioproduct Firms

Characteristics	Number of firms ^(a)	
	YES	NO
Public Firm	25 (19)	108 (81)
Subsidiary of a multinational enterprise	8 (6)	125 (94)
Spin-off	37 (28)	96 (72)
Average age	17	

Source: Statistics Canada, BUDS 2001

Note:

^(a) Percentages are in parentheses

IV What Types of Bioproducts are Being Developed?

4.1 Number of Bioproducts being developed

In 2001, a total of 805 bioproducts were being made or developed. Of these, small firms were developing 424 products, or 53%. Comparatively, medium-sized had 92 products under development and large firms, 289. Firms in Quebec were developing the largest number of products, 250 or 31%. They were followed in decreasing order by firms in British Columbia at 207, those in Ontario at 203, the Atlantic provinces at 78, and the Prairies at 67 (Table 5).

As also shown by figures in Table 5, the overwhelming majority of these products, 588, were either approved, on the market or in production. One hundred and forty eight (148) others were at the R&D stage, 69 were in the proof of product/product development stage. This result coupled with our previous finding that 62% of the 133 bioproduct firms were at the approval/on market/ in production stage, implies that most of the firms were either about or already reaping the benefits of their investments in bioproducts.

Table 5: Number of Bioproducts Developed by Firm Size, Province, and Stage of Development, 2001

A) Firm size	Number of bioproducts
Small firms (50 and fewer employees)	424
Medium firms (51 to 150 employees)	92
Large firms (Over 150 employees)	289
Total	805
B) Province	
British Columbia	207
Prairies	67
Ontario	203
Quebec	250
Atlantic	78
Total	805
C) Stage of Development	
R&D	148
Proof of concept/product development	69
Approval/on market/in production	588
Total	805

Source: Statistics Canada, BUDS 2001

Note:

x: suppressed to meet the confidentiality requirements of the Statistics Act

4.2 Types of Bioproducts

Bioprocessing based bioproducts, i.e. products developed or made using enzymes and bacteria culture involved the largest number of firms, 49 out of 133 firms. Water cleaning and decontamination using biofiltration, bioremediation, and phytoremediation involved the second largest number of firms, 45. Bioproducts from Non-food agriculture as it relates to the making and development of fuels, lubricants, commodity and fine chemical feedstocks, and cosmetics is third in importance with 28 firms. Aquaculture and bioproducts for air cleaning and decontamination are other important areas for bioproduct development with respectively 23 and 21 firms. Other fields are soil cleaning and decontamination products, 16 firms, forest based bioproducts, 12 firms, and bioproducts for energy production and mining, 9 firms (Table 6).

Thus, by and large, the development of bioprocessing based bioproducts, water cleaning and decontamination, and non-food agricultural production based bioproducts involved most firms. However, the latter two sectors with respectively 65 and 72 bioproducts were outpaced by Aquaculture in terms of the number of products, 194. There were 352 bioprocessing based bioproducts, making this sector the largest, both in terms of the number of firms and the number of products as well. Comparatively, there were fewer bioproducts made or developed for mining

and energy production using microbiologically enhanced recovery methods, industrial bioprocessing, and biodesulpharization, only 12 products (Table 6).

Table 6: Distribution of Firms by Types of Bioproducts and Number of Bioproducts, 2001

Types of Bioproduct	Number of Firms ^(a)	Number of bioproducts
Non-food Agricultural based	28	72
Energy/Mining	9	12
Forest Products	12	40
Air	21	39
Water	45	65
Soil	16	31
Aquaculture	23	194
Bioprocessing	49	352

Source: Statistics Canada, BUDS 2001

Note:

^(a) Figures in column 2 do not add up to 133 as there are firms that are developing more than one type of bioproducts

V Which Sectors are Involved in Developing Bioproducts?

Bioproduct firms are found in several economic sectors. More than any other sector, bioprocessing and the environment sectors accounted for the largest number of firms, 40 and 32, respectively. Together, these two sectors had 53% of all the 133 bioproduct firms in 2001. These were also the sectors where the largest number of bioproducts were developed, 367 for bioprocessing and 249 for the environment sector. Agriculture followed with 22 firms and 64 products, Human Health with 18 firms and 30 products, Aquaculture with 11 firms and 61 products, and natural resources with 10 firms and 33 products (Table 7).

The difference between figures in Tables 6 and 7 indicates that development of bioproducts for a given sector is not limited to firms in that sector. For example, from Table 7, there were only 11 firms in Aquaculture developing 61 products, far fewer than the 194 aquacultural bioproducts developed by 23 firms as reported in Table 6. This implies that there were on-aquaculture firms developing or making bioproducts intended for use in Aquaculture. This holds true for the other sectors.

Table 7: Distribution of Bioproduct Firms by Sector of Activity, 2001

Sector of activity	Number of firms	Number of bioproducts
Human health	18	30
Agriculture	22	64
Natural resources	10	33
Environment	32	249
Aquaculture	11	61
Bioprocessing	40	367
Total	133	805

Source: Statistics Canada, BUDS 2001

VI Bioproduct Employment, Revenues, R&D Expenditures, Export, and Import Revenues

As shown in Table 8, there were 81 firms out of 133 which had products exclusively in the selected bioproduct fields in Table 1. It may be reasonably assumed that these firms' biotechnology employment, biotech revenues, biotech R&D expenditures as reported in the 2001 BUDS are solely from their use of biotechnologies to make or develop bioproducts. Consequently, these indicators may be referred to as bioproduct employment, bioproduct revenues, bioproduct R&D expenditures⁵.

These 81 firms were employing 1,242 people in their biotechnology related activities. They earned \$428 million in revenues, spent \$67 million in R&D. Relatively to figures reported in Table 3, these translate into 3% of total employment and total revenues, and 11% of total R&D expenditures of the 133 bioproducts firms in the study.

They were mostly small firms, 56 out of 81 firms and were located principally in Quebec, 30 firms, British Columbia, 22 firms, and Ontario, 15 firms.

⁵ Instruction in the Note to the Readers apply equally to this set of firms. In fact, figures presented here do not indicated bioproduct employment, revenues, R&D expenditures in Canada. They refer to the level of these indicators for these 81 firms, which are far fewer than the actual number of firms that may be involved in developing or making bioproducts in Canada.

Table 8: Employment, Revenues, R&D Expenditures for Bioproduct Firms with Products exclusively in the Selected Bioproduct Fields by Size and Province, 2001

	Employment	Revenues (\$000,000)	R&D expenditures (\$000,000)
A) Firm Size			
Small firms (50 and fewer employees)	507 (56)	350 (56)	28 (56)
Medium firms (51 to 150 employees)	410 (14)	53 (14)	18 (14)
Large firms (Over 150 employees)	325 (11)	25 (11)	21 (11)
Total	1,242 (81)	428 (81)	67 (81)
B) Province			
British Columbia	176 (22)	130 (22)	18(22)
Prairies	59 (7)	62 (7)	2 (7)
Ontario	307 (15)	79 (15)	15 (15)
Quebec	664 (30)	137 (30)	32 (30)
Atlantic	36 (6)	20 (6)	1 (6)
Total	1,242 (81)	428 (81)	67 (81)

Source: Statistics Canada, BUDS 2001

Notes:

- 1) The number of firms is in parentheses;
- 2) Due to rounding, sum of figures in the cells may differ from total
- 3) x: suppressed to meet the confidentiality requirements of the Statistics Act;

VII Limits of the study

Data used in this study are from a survey designed to capture biotechnology activities in Canada in 2001. At the request of Agriculture and Agri-Food Canada, respondents were asked in the first phase of the questionnaire to report whether or not they were developing or making any bioproduct. One hundred (100) firms also reported developing products that require the use of biotechnologies. In-depth data was collected from these 100 firms that overlapped in the biotechnology activities. Thus, no information was collected on the remainder of the firms identified in phase 1 and that reported making or developing bioproducts.

Additional information collected in the second phase of the survey on the types of product developed was used to identify additional firms involved in the development of bioproducts. At the end of this process, 133 firms were identified as bioproduct developers. As suggested by findings in this paper, the development of bioproducts has become an intrinsic part of many Canadian biotechnology firms' daily activities. However the picture provided by these findings is incomplete and points to some limits of the study. These limits are of two types. First and foremost, as revealed by comparing results from phase 1 and phase 2 of the 2001 BUDS, a number of the "potential" bioproduct firm population could not be included in the study. This exclusion concerns 1) all the firms that said "YES" to the phase 1 bioproduct question but were not involved in the use and development of biotechnology-based products and 2) 43 firms from

phase 1 that were surveyed in phase 2 but for which not enough information was available to determine their true involvement in the making or development of bioproducts. Second, the survey is a biotechnology survey, not a bioproduct survey. Furthermore, the 133 firms in this study are firms that use biotechnologies to develop or make products/processes. This leaves out firms that use other bioproduct development techniques. Thus, these 133 firms underestimate the actual number of Canadian bioproduct firms. Other relevant questions that could not be answered in this study due to data limitation include the number of employees dedicated to bioproduct development, the share of revenues coming from the sales of bioproducts, the share of total R&D expenditures dedicated to bioproduct research and development. Consequently, data collected and presented in this paper provide a partial picture of bioproduct development in Canada. This study shows that there are firms engaged in the production of bioproducts and the characteristics of these firms are provided.

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Volume 26

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Appendix I



Confidential once completed

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, Chapter S19. Completion of this questionnaire is a legal requirement under the Statistics Act.

Version française au verso



Purpose of Survey

Statistics Canada is conducting this survey in order to develop information on biotechnology and related technologies such as functional foods, nutraceutical and bioproducts by identifying industry sectors where these activities take place. Please report on *Canadian activities of your firm in biotechnology, functional foods, nutraceutical or bioproducts*. Your firm may have responded to biotechnology questions in previous surveys, but there is also an increasing demand for information on other technologies and their impact on the Canadian economy.

Authority

Collected under the authority of the *Statistics Act*,
Revised Statutes of Canada, 1985, Chapter S19.
Completion of this questionnaire is a legal
requirement under the *Statistics Act*.

Confidentiality

Statistics Canada is prohibited from publishing any statistics that would divulge information obtained from this survey that relates to any identifiable business, institution or individual. Data is treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the *Statistics Act* are not affected by either the *Access to Information Act* or any other Legislation.

Federal-Provincial Agreement

In order to avoid duplication of enquiry, reduce the cost of collection, and provide consistent statistics, Statistics Canada has entered into an agreement with the Institut de la Statistique du Québec, under Section 11 of the *Statistics Act*. Data collected from Québec firms in this survey will be transmitted to the Institut de la Statistique du Québec. The *Statistics Act* of Québec includes the same provisions for confidentiality and penalties for disclosure of information as the Federal *Statistics Act*.

Instruction

A knowledgeable senior person in your firm, such as an R&D manager or production manager, can quickly complete this questionnaire. Please fill in the contact information below, answer all 3 questions and return the completed questionnaire in the accompanying self addressed prepaid envelope to Statistics Canada by March 7, 2002.

 Assistance

If you have questions or require assistance please contact:

Claire Racine-Lebel
7th floor, RHCoats Building
Statistics Canada

Telephone: 613-951-6309
Fax: 613-951-9920
E-mail: Sieidinfo@statcan.ca

Please provide the following information:

Name of person completing this form	Telephone number Area code [] [] [] - [] [] [] [] - [] [] [] []
Title	Fax number [] [] [] [] - [] [] [] []
Web address	E-mail

1. Does your firm currently use or develop biotechnology in its activities?

- ☐ Yes
☐ No

Examples of biotechnologies:

DNA genomics, pharmaco-genetics gene probes, DNA sequencing/synthesis/amplification, genetic engineering. Protein/peptide sequencing/synthesis, lipid/protein engineering, proteomics, hormones and growth factors, cell receptors/signalling/pheromones, cell/tissue culture, tissue engineering, hybridisation, cellular fusion, vaccine/immune stimulants, embryo manipulation, bioreactors, fermentation, bioprocessing, bioleaching, bio-pulping, bio-bleaching, biodesulphurization, bioremediation, biofiltration, gene therapy, viral vectors, bioinformatics, other.

2. Does your firm currently make or develop functional foods or nutraceutical products?

- ☐ Yes
☐ No

Functional food

is a conventional food, beverage, or ingredient enriched with functional components beneficial in disease prevention or disease-risk management, beyond basic nutritional functions. A food, beverage or ingredient may be made functional through a variety of means, such as the addition of components, extraction, fractionation, processing, plant or livestock breeding, livestock feeding techniques, genetic modification, other.

Nutraceutical

is a product isolated or purified from foods (includes herbs and botanicals) that is generally sold in medicinal forms not usually associated with food. A nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic disease.

3. Does your firm currently make or develop a bioproduct?

- ☐ Yes
☐ No

Bioproduct

a commercial or industrial product (other than food and feed) made with biological or renewable domestic agricultural (plant, animal), marine or forestry materials, such as, bio-energy (heating and electricity), bio-fuels (ethanol and bio-diesel), biochemicals, fiberboard, textiles and bio-plastics, other.

Thank you for your cooperation

Please return the completed questionnaire
in the accompanying self addressed prepaid envelope

Appendix II

Biotechnology Use and Development Survey - 2001

Confidential when completed

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, c. S-19.
Completion of the questionnaire is a legal requirement under the Statistics Act.

Si vous préférez ce questionnaire en français, veuillez cocher



Information for the Respondent

Survey Purpose

Statistics Canada is undertaking this survey to produce a profile of firms engaged in biotechnology activities in Canada. The survey focuses on the characteristics and activities of firms that use or develop biotechnology as part of their company's activity.

Biotechnology is an emerging sector of the Canadian economy and its impact has the potential to be felt through all parts of Canada's society. An accurate understanding of biotechnology requires comprehensive data. Information from this survey may be used by businesses for economic or market analysis, by trade associations to study industry performance, government departments and agencies to assist policy formation, and by the academic community for research purposes. Statistics Canada may create a database by combining survey data with existing Statistics Canada data records.

Please report 2001 on Canadian biotechnology activities of your firm unless a specific question indicates otherwise. Complete a separate questionnaire for each company engaged in biotechnology activities in Canada.

Confidentiality

Statistics Canada is prohibited from publishing any statistics that would divulge information obtained from this survey that relates to any identifiable business, institution or individual. Data is treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the *Statistics Act* are not affected by either the Access to Information Act or any other Legislation.

Federal-Provincial Agreement

In order to avoid duplication of enquiry, reduce the cost of collection and provide consistent statistics, Statistics Canada has entered into an agreement with the Institut de la Statistique du Québec. Under Section 11 of the Statistics Act data collected from Quebec firms in this survey will be transmitted to the Institut de la Statistique du Québec. The Statistics Act of Quebec includes the same provisions for confidentiality and penalties for disclosure of information as the Federal Statistics Act.

Who Should Complete This Questionnaire?

A senior manager, scientist/researcher or production manager should complete this questionnaire.



Assistance

If you have questions or require assistance please contact:

Claire Racine-Lebel
Science, Innovation and Electronic Information
Division

Statistics Canada
Tunneys Pasture
Ottawa K1A 0T6

Telephone: 613-951-6309 (Call collect)
Fax: 613-951-9920
E-mail: Sieidinfo@statcan.ca

Please provide the following information:

Name of person completing this form	Telephone number Area code - - - - -
Title	Fax number -
Web address	E-mail

Section 1 - Biotechnologies in Use

This section measures the use of biotechnologies in your firm.

1. Using the table below, please indicate the use your firm makes of each type of biotechnology listed. Check the applicable circle or circles.

Biotechnologies	Currently Used in Operation 0	If currently using, do you use them for			Number of Years in Use 4	If No ▼ Do you plan to use within 3 years? 5
		Product/ Process Development 1	Current Production 2	Environmental Purposes 3		
DNA - the coding						
1000 Genomics/Pharmaco-genetics	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1010 Gene probes	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1020 DNA sequencing synthesis amplification, Genetic Engineering	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
Proteins and Molecules - the functional blocks						
1100 Protein/peptide sequencing/ synthesis	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1110 Lipid/protein engineering	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1120 Proteomics	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1130 Hormones, growth factors, pheromones	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1140 Cell receptors signalling	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
Cell and Tissue Culture, and Engineering						
1200 Cell/ tissue culture, Embryo manipulation	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1210 Tissue engineering	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1220 Hybridization	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1230 Cellular fusion	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1240 Vaccine/immune stimulants	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
Process Biotechnologies						
1300 Bioreactors	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1310 Fermentation, Bioprocessing	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No

Biotechnologies	Currently Used in Operation	If currently using, do you use them for			Number of Years in Use	If No ▼ Do you plan to use within 3 years?
		Product/ Process Development	Current Production	Environmental Purposes		
	0	1	2	3	4	5
1320 Biobleaching, Bio-pulping, Biobleaching, Biodesulphurization	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1330 Bioremediation, Biofiltration	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
Sub-Cellular Organisms						
1400 Gene Therapy	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1410 Viral Vectors	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
Other						
1500 Bioinformatics	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1510 Nanobiotechnologies	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No
1520 Other, Please Specify: _____	☐ Yes → ☐ No	☐	☐	☐		☐ Yes ☐ No

If you use at least one of the
biotechnologies listed in Question 1

► Go to Section 2

If you do not use any of the
biotechnologies listed in Question 1

► Please return the questionnaire in the
accompanying prepaid return envelope.

Thank you for your assistance.

Section 2 - The Effects of Biotechnology on Your Firm

This section measures the factors influencing the use of biotechnology in your firm and the impact of biotechnology use on your firm's performance.

2. Using the table below, please rate the level of influence of each factor on increasing your use of biotechnology.

	Importance				
	Low 1	2	3	4	High 5
Inputs					
2000 Access to capital	☐	☐	☐	☐	☐
2010 Access to technology/information	☐	☐	☐	☐	☐
2020 Access to human resources	☐	☐	☐	☐	☐
Markets					
2100 Size of Domestic Market	☐	☐	☐	☐	☐
2110 Access to international markets	☐	☐	☐	☐	☐
2120 Information about markets	☐	☐	☐	☐	☐
2130 Distribution & marketing channels	☐	☐	☐	☐	☐
Constraints					
2200 Public perception/acceptance	☐	☐	☐	☐	☐
2210 Cost of regulatory approval	☐	☐	☐	☐	☐
2220 Time required for regulatory approval	☐	☐	☐	☐	☐
2230 Limited international harmonization	☐	☐	☐	☐	☐
2240 Patent rights held by others	☐	☐	☐	☐	☐
2250 Lack of protection for intellectual property	☐	☐	☐	☐	☐
2260 Other, Please specify:	☐	☐	☐	☐	☐

3. For each of the performance factors listed below, please rate the level of impacts of biotechnology use on your firm's performance.

	Importance				
	Low 1	2	3	4	High 5
Increased Productivity					
3000 Labour costs	☐	☐	☐	☐	☐
3010 Capital costs	☐	☐	☐	☐	☐
3020 Energy costs	☐	☐	☐	☐	☐
Improved Products					
3100 New products or processes introduced	☐	☐	☐	☐	☐
3110 Product range increased	☐	☐	☐	☐	☐
3120 Product quality increased	☐	☐	☐	☐	☐
Knowledge Based					
3200 Developing new areas for R&D	☐	☐	☐	☐	☐
3210 Increase efficiency for R&D	☐	☐	☐	☐	☐
Improved Market Performance					
3300 Market position improved	☐	☐	☐	☐	☐
3310 New Market Niche Developed	☐	☐	☐	☐	☐
3320 Sales increased	☐	☐	☐	☐	☐
3330 Other, Please Specify:	☐	☐	☐	☐	☐

Concerns have been expressed about the availability of skilled biotechnology employees. Your cooperation in careful completion of this section is essential in developing an accurate understanding of human resources in biotechnology. For the purpose of this survey Employees are defined as those workers for whom you completed a Canada Customs and Revenue Agency T-4 statement for the 2001 tax year. Include working owners. Do not include students. Only count employees working in Canada. If '0' (zero) indicate '0'.

Number of Biotechnology Employees

4. a) How many employees does your firm employ in Canada?
Please Report Typical Employment Level for 2001.

4000

- b) How many employees have biotechnology-related responsibilities?
Please Report Typical Employment Level for 2001.

4010

c) **Full-time Biotechnology Employees**

For each group listed below indicate how many are full-time biotechnology employees (50% or more of their time spent on biotech related activities)? If an employee fulfills more than 1 duty, report their primary responsibility. Count each person only once. Please Report Typical Employment Level for 2001.

Position	Number of full-time
Scientific Research & Direction	4100
Technicians	4110
Regulatory/Clinical Affairs	4120
Production	4130
Finance/Marketing	4140
Management	4150
Other, Please Specify:	4160
Total Full-time employees	4170

d) **Part-time Biotechnology Employees**

- For each group listed below indicate how many are Part-time biotechnology employees (less than 50% of their time spent on biotech related activities)? If an employee fulfills more than 1 duty, report their primary responsibility. Count each person only once. Please Report Typical Employment Level for 2001.

Position	Number of part-time
Scientific Research & Direction	4200
Technicians	4210
Regulatory/Clinical Affairs	4220
Production	4230
Finance/Marketing	4240
Management	4250
Other, Please Specify:	4260
Total Part-time employees	4270

e) **Total Number of biotechnology employees.**

Total full-time and part-time employees with biotechnology-related responsibility (Box 4170 + Box 4270)

4011

This number must equal 4010 above.

Recruiting Practices

5. a) Does your firm have unfilled biotechnology-related positions?

5000 ☐ No ► Go to question 5b

☐ Yes ► In the table below indicate the number of unfilled positions by category.

Position	Number of Unfilled Positions
Scientific Research & Direction	5100
Technicians	5110
Regulatory/Clinical Affairs	5120
Production	5130
Finance/Marketing	5140
Management	5150
Other, Please Specify:	5160
Total unfilled positions	5170

b) Did your firm attempt to recruit any biotechnology employees in 2001?

5200 ☐ No ► Go to question 8

☐ Yes ► Were you successful?

5300 ☐ No ► Go to question 6

☐ Yes ► How many did you hire?

5310

c) What sources were successfully used in recruiting biotechnology staff?

5400 ☐ University Recruitment

5410 ☐ Temporary/Contract Staff

5420 ☐ Employment agencies/Headhunters

5430 ☐ Professional Associations

5440 ☐ Own Staff/Incentive program

5450 ☐ Other Biotechnology Firms

5460 ☐ Pharmaceutical Firms

5470 ☐ Newspaper/Journal

5480 ☐ Student Internship

5490 ☐ Internal Training of Staff

6. Please rate the impact of the following factors on your efforts in filling biotechnology-related vacancies.

Factors	Importance				
	Low 1	2	3	4	High 5
Candidate Factors					
6000 Compensation requirements by candidates too high	☐	☐	☐	☐	☐
6010 Candidates unwilling to relocate	☐	☐	☐	☐	☐
6020 Lack of experience	☐	☐	☐	☐	☐
Firm Factors					
6100 Capital/resources insufficient to attract candidates	☐	☐	☐	☐	☐
External Factors					
6200 Lack of qualified candidates	☐	☐	☐	☐	☐
6210 Competition for qualified candidates	☐	☐	☐	☐	☐
6220 Other, Please Specify	☐	☐	☐	☐	☐

7. Did you attempt to hire biotechnology staff from outside of Canada in 2001?

7000 ☐ No ► Go to question 8

☐ Yes ► Was your firm successful in hiring from outside of Canada?

7010 ☐ No ► Go to question 8.

☐ Yes ► How many staff from outside Canada did you hire?

7020

8. Did any biotechnology personnel leave your firm in 2001?

8000 ☐ No ► Go to question 9

☐ Yes ► How many?

8010

Section 4 - Biotechnology Products

This section measures the development of new biotechnology products and processes by your firm.

9. a) Do you have biotechnology products/processes on the market?

9000 ☐ No ► Go to question 9b)

☐ Yes ► What year was the most significant product first introduced?

9010

b) Is your firm currently developing products that require the use of biotechnology?

9100 ☐ No ► Go to question 9c)

☐ Yes ► What year will the most significant of these products reach market?

9110

c) Is your firm currently developing processes that require the use of biotechnology?

9200 ☐ No ► Go to question 9d)

☐ Yes ► What year will the most significant of these processes be completed?

9210

d) Do you consider biotechnology central to your firm's activities or strategies?

9300 ☐ No

☐ Yes

e) If you answered "Yes" to any
Part of Question 9

► Go to Q10

Otherwise

► Please return the questionnaire in the
accompanying prepaid return envelope.

Thank you for your assistance.

10. In the table below, for each sector listed please indicate the number of biotechnology products or processes your firm currently has for each stage of development.

Biotechnology Sector	Number of biotechnology products/processes by development stage			
	Research & Development 0	Pre-clinical trials/ Confined field trials 1	Regulatory phase/ Unconfined release assessment 2	Approved/ On market/in production 3
Human Health				
10000 Diagnostics (e.g. biosensors, immunodiagnostics, gene probes)				
10010 Therapeutics (e.g. vaccines, immune stimulants, biopharmaceuticals)				
10020 Drug Delivery				
Agriculture Biotechnology				
10100 Plant Biotechnology (e.g. tissue culture, embryogenesis, genetic markers, genetic engineering)				
10110 Animal Biotechnology (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)				
10120 Non-food Agriculture (e.g. fuels, lubricants, commodity and fine chemical feedstocks, cosmetics)				
Natural Resources				
10200 Energy (e.g. microbiologically enhanced petroleum recovery, industrial bioprocessing, biodesulphurization)				
10210 Mining (e.g. microbiologically enhanced mineral recovery, industrial bioprocessing, biodesulphurization)				
10220 Forest Products (e.g. biopulping, biobleaching, biopesticides, tree biotechnology, industrial bioprocessing)				
Environment				
10300 Air (e.g. bioremediation, diagnostics, phytoremediation, biofiltration)				
10310 Water (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
10320 Soil (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
Aquaculture				
10400 Fish health, broodstock genetics, bioextraction				
Bioinformatics				
10500 Genomics & molecular modelling (e.g. DNA/RNA/protein synthesising & databases for humans, plants, animals, and micro-organisms)				
10510 Gene therapy (e.g. gene identification, gene constructs, gene delivery)				
Food Processing				
10600 Bioprocessing (e.g. using enzymes and bacteria culture)				
10610 Functional Foods/Nutraceuticals (e.g. probiotics, unsaturated fatty acids)				
10620 Other, Please Specify				

11. a) What is the total time required to bring your principal biotechnology product or process from the initial development phase/proof of concept stage to the market? If still in pre-market stages provide an estimate.

11000 Years 11001 Months

- b) What is the total cost to bring your principal biotechnology product or process from the initial development phase/proof of concept stage to the market? If still in pre-market stages provide an estimate.

11100 \$,000

Section 5 - Business Practices

Contracting Out

12. a) Did your firm contract out biotechnology related activities in 2001?

12000 ☐ No ► Go to question 12d)

☐ Yes ► For each partner type listed below, please indicate the number and value of contracts for each group listed.

Partner Type	Number of Contracts	Total Value of Contract in 2001 for (\$,000)			
		Purpose of Contract			
		R&D 1	Regulatory/ clinical 2	Management/ Production 3	Other 4
12100 Private Entities (C.R.O.'s / other Firms, etc)		\$,000	\$,000	\$,000	\$,000
12110 Public Entities (Universities / Government Labs.)		\$,000	\$,000	\$,000	\$,000

- b) Did you contract out to organizations outside of Canada?

12200 ☐ No ► Go to question 13

☐ Yes ► For each organization listed below, please indicate the percentage (%) of your firm's total contracting out in 2001.

Organization	% of total contracting out
12300 Private research lab	%
12310 University/Hospital	%
12320 Government lab	%
12330 Other biotechnology firm	%
12340 Other, Please Specify:	%

- c) Rate the level of importance of each of the following reasons on your decision to contract out.

Reasons for Contracting Out	Importance				
	Low 1	2	3	4	High 5
12400 Knowledge not available internally	☐	☐	☐	☐	☐
12410 Access outside scientific expertise	☐	☐	☐	☐	☐
Cost Reduction Related to:					
12420 R&D Activities	☐	☐	☐	☐	☐
12430 Regulatory/Clinical Affairs	☐	☐	☐	☐	☐
12440 Production	☐	☐	☐	☐	☐
12450 Precursor to a formal agreement	☐	☐	☐	☐	☐
12460 Reduce risk/exposure	☐	☐	☐	☐	☐
12470 Other, Please Specify:	☐	☐	☐	☐	☐

d) Does your firm provide contract services to other firms or organizations?

12500 ☐ No ► Go to question 13

☐ Yes ► For each type of contract services listed below, please indicate the number of contracts entered into in 2001 and the revenues received for each category.

Contract Services	Number of contracts entered in 2001 0	Revenue received from this source in 2001 1
12600 Routine Lab services		\$,000
12610 Specialized Lab services		\$,000
12620 Production/manufacturing services		\$,000
12630 Other, Please Specify: _____		\$,000
12640 Total		\$,000

Collaborative Arrangements

Cooperative and collaborative arrangements involve the active participation in projects between your company and other companies or organizations in order to develop and/or continue work on new or significantly improved biotechnology processes and/or products. **Pure contracting-out work is not regarded as collaboration.**

13. a) Was your firm involved in biotechnology-related cooperative/collaborative arrangements with other companies or organizations in 2001?

13000 ☐ No ► Go to question 14

☐ Yes ► Provide the number of arrangements by purpose and partner type

Arrangement Purpose	Number of Arrangements by Partner Type			
	Biotech Firm 0	Non-biotech Firm 1	Academic Institution/ Hospital 2	Government lab or agency 3
13100 To conduct research & development (R&D)				
13110 Regulatory affairs				
13120 Access others' patents				
13130 Production/manufacturing				
13140 Access markets/distribution channels				
13150 Access capital				
13160 Access to Intellectual property from partner				
13170 Other, Please Specify _____				
13180 Total number				

Intellectual Property

14. a) Did your firm grant biotechnology related intellectual property (IP) rights to another firm?

14000 ☐ No ► Go to question 14b)

☐ Yes ► For each type of intellectual property instrument listed below please indicate the number of IP rights granted by country and the total income received from IP licensing in 2001.

Intellectual Property Instrument	Number with Canadian firms 0	Number with USA firms 1	Number with other country firms 2	Revenue from IP licensing in 2001 3
14100 Licensing Agreement				\$.000
14110 Patents				\$.000
14120 Other, Please Specify				\$.000

b) Did your firm obtain biotechnology related intellectual property rights from another firm?

14200 ☐ No ► Go to question 15

☐ Yes ► Complete the following table

Intellectual Property Instrument	Number with Canadian firms 0	Number with USA firms 1	Number with other country firms 2	Cost to your firm of obtaining IP in 2001 3
14300 Licensing Agreement				\$.000
14310 Patents				\$.000
14320 Other, Please Specify				\$.000

15. a) Does your firm have biotechnology related patents or pending patents?

15000 ☐ No ► Go to question 16

☐ Yes ► How many?

Indicate the distribution of biotechnology related patents and pending patents your firm has by Patent Office

	Canadian Intellectual Property Office (CIPO) 0	U.S. Patent & Trademark Office (USPTO) 1	European Patent Office 2	Other 3
15100 Existing Patents				
15110 Pending Patents				

b) Provide the number of unique patent applications your company submitted in

Number

15200 2000	
15210 2001	

Section 6 - Firm Characteristics and Financial Profile**Revenues and Research and Development (R&D) Expenditures**

16. Please complete the following table. If information is not available please provide a carefully considered estimate. Report for fiscal years and in thousands of dollars (\$,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 0	2001 1	2004 Forecast 2
16000 Total Firm Sales/Revenues (all sources)	\$.000	\$.000	\$.000
16010 % of revenues from Biotechnology	%	%	%
16020 Total R&D spending	\$.000	\$.000	\$.000
16030 Total spending on Biotechnology R&D	\$.000	\$.000	\$.000
16040 % of Biotechnology R&D spending contracted out	%	%	%

17. Does your firm have sales of biotechnology products?

17000 ☐ No ► Go to question 18

☐ Yes ► What percentage of your sales of biotechnology products came from.

	%
Direct sales to consumers or distributors	17100
Products sold to other firms to be used as inputs	17110

Firm History

18. Is your firm a public firm?

18000 ☐ No ► Go to question 19

☐ Yes ► What year was the Initial Public Offering (IPO)? 18100

19. What year was your firm or spin-off established? 19000

20. Has your firm merged with another firm? (Include acquisition of another firm or by another firm)

20000 ☐ No ► Go to question 21

☐ Yes ► What year did the merge take place? 20100

21. Is your firm a subsidiary of a Multi-National Enterprise (MNE)?

21000 ☐ No ► Go to question 22

☐ Yes

22. a) Is your firm a spin-off? A spin-off is defined as a new firm created to transfer and commercialize inventions and technology developed in universities, firms or laboratories.

22000 ☐ No ► Go to question 23

☐ Yes ► Was your firm a spin-off from ►

University/hospital	☐ 22100
Another Biotech company	☐ 22110
Non-biotech firm	☐ 22120
Government Agency/lab	☐ 22130
Other, Please Specify	☐ 22140

Raising Capital

A great deal of attention has focused on the ability of biotechnology firms to raise capital and the challenges of raising capital. Questions in this section are intended to collect information in order to address this critical issue facing the biotechnology sector.

23. a) Did your firm attempt to raise capital for biotechnology related purposes in 2001?

23000 ☐ No ► Go to question 23h)

☐ Yes ► Were you successful in raising capital?

23100 ☐ No ► Go to question 23c)

☐ Yes ► How much 23110 \$,000

b) Did you reach your target?

23200 ☐ No ► Go to question 23c)

☐ Yes ► Go to question 23d)

23. c) What reasons did the lender give in limiting or refusing your request for capital?

Check all that apply.

- Biotechnology product/process not sufficiently developed ☐ 23300
- Biotechnology product line or portfolio limited in scope ☐ 23310
- Insufficient specific management skills/expertise ☐ 23320
- Capital not available due to market conditions ☐ 23330
- Further product development or proof of concept required ☐ 23340
- Lender does not fund development projects ☐ 23350
- Other, Please Specify ☐ 23380

d) What sources provided funding?

	% of total raised from each source?	
Canadian based Venture Capital	23400	%
American based Venture Capital	23410	%
Conventional sources (i.e. banks)	23420	%
Angel Investors/Family	23430	%
Government sources	23440	%
Other, Please Specify	23450	%

e) For your most important biotechnology product or process, please indicate the current stage of development.

Stage of Development

- R&D ☐ 23500
- Pre-Clinical ☐ 23510
- Clinical Trials ☐ 23520
- Market Entry ☐ 23530

For your most important biotechnology product or process, please indicate total spending since the beginning of development.

	Stage of Development	Total spending up to and including current stage
23600	R&D	\$,000
23610	Pre-Clinical	\$,000
23620	Clinical Trials	\$,000
23630	Market Entry	\$,000

For your most important biotechnology product or process, please estimate the total amount of capital required to complete each stage, as well as the total capital available.

	Stage of Development	Total additional capital required to complete stage 1	Total capital available to complete stage (include all committed funds) 2
23700	R&D	\$,000	\$,000
23710	Pre-Clinical	\$,000	\$,000
23720	Clinical Trials	\$,000	\$,000
23730	Market Entry	\$,000	\$,000

23. f) How long do you anticipate this capital (committed and on hand) lasting?

23800	Years	23810	Months
-------	-------	-------	--------

g) Why did you raise or attempt to raise capital? Indicate each category that applies to your firm

- 23900 ☐ R&D purposes/Expand R&D capacity
- 23910 ☐ Repay current investors
- 23920 ☐ Commercialize current R&D projects
- 23930 ☐ Clinical/regulatory expenses
- 23940 ☐ Develop production/manufacturing capability
- 23950 ☐ Other, Please Specify:

h) Do you plan on raising capital in 2002?

- 24000 ☐ No ► Go to question 24
- ☐ Yes ► How much do you plan to raise? ►
- <\$1,000,000 ☐ 24010
- \$1,000,000-\$5,000,000 ☐ 24020
- >\$5,000,000 ☐ 24030

Tax Incentives

24. a) Did your firm have biotechnology R&D expenditures in any of the previous 5 years?

- 24100 ☐ No ► Go to question 26
- ☐ Yes ► In the past 5 years did your firm apply for benefits for biotechnology related activities under the Scientific Research and Experimental Development (SR&ED) tax program?
- 24200 ☐ Yes ► How much did you apply for in 2001? \$ ► Go to question 24b
- ☐ No ► Why?
- Complexity of application process ☐ 24300
- Uncertainty of eligibility ☐ 24310
- Did not meet eligibility requirements ☐ 24320
- Other, Please Specify: ☐ 24330

b) Have any of your SR&ED credits expired?

- 24400 ☐ No
☐ Yes

25. Did your firm apply for any provincial R&D tax benefit or incentive?

25000 ☐ Yes

☐ No ► Why did you not apply?

Complexity of application process ☐ 25100

Uncertainty of eligibility ☐ 25110

Did not meet eligibility requirements ☐ 25120

Other, Please Specify ☐ 25130

Imports & Exports

26. Did your firm export biotechnology products?

26000 ☐ No ► Go to question 27

☐ Yes ► Please complete the following table. Report for fiscal years and in thousands of dollars (\$,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 0	2001 1	Forecast for 2004 2
26100 Total Exports Revenues (all sources)	\$,000	\$,000	\$,000
26110 % export revenues from Biotechnology	%	%	%

Regional Distribution

26200 % export revenues to US	%	%	%
26210 % export revenues to Europe	%	%	%
26220 % export revenues to Asia	%	%	%
26230 % export revenues to other regions	%	%	%

27. Did your firm import biotechnology products?

27000 ☐ No ► Go to question 28

☐ Yes ► Please complete the following table. Report for fiscal years and in thousands of dollars (\$,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 0	2001 1	Forecast for 2004 2
27100 Total Import Expenditures (all sources)	\$,000	\$,000	\$,000
27110 % import expenditures from Biotechnology	%	%	%

Regional Distribution

27200 % import expenditures to US	%	%	%
27210 % import expenditures to Europe	%	%	%
27220 % import expenditures to Asia	%	%	%
27230 % import expenditures to other regions	%	%	%

Strategies Used in 2001

28. In the table below rate the significance of each of the following strategies on your firm's performance in 2001.

	Importance				
	Low 1	2	3	4	High 5
Knowledge development strategies					
28000 Captured and used knowledge obtained from other industry sources such as industry associations, competitors, clients and suppliers	☐	☐	☐	☐	☐
28010 Captured and used knowledge obtained from public research institutions including universities and government laboratories	☐	☐	☐	☐	☐
28020 Used and updated databases of scientific information	☐	☐	☐	☐	☐
28030 Developed firm policies and practices for knowledge/intellectual property protection	☐	☐	☐	☐	☐
28040 Developed/encouraged staff education/upgrading	☐	☐	☐	☐	☐
28050 Conducted an Intellectual Property Audit to ensure protection of products and processes at all stages of development	☐	☐	☐	☐	☐
Business strategies					
28100 Increased firm size through acquisition, merger or joint venture	☐	☐	☐	☐	☐
28110 Downsize operations of the firm	☐	☐	☐	☐	☐
28120 Entered product trials/adapted products or processes for increased market penetration	☐	☐	☐	☐	☐
28130 Began new research & development project	☐	☐	☐	☐	☐
28140 Expanded into foreign markets	☐	☐	☐	☐	☐
28150 Other, Please Specify: _____	☐	☐	☐	☐	☐

29 a) Does your firm develop, produce or sell Living Modified Organisms (LMO)?

Living modified organism means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology. A living organism means any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses and viroids.

Source: Cartagena Protocol on Biosafety

29000 ☐ No

☐ Yes ► If yes, how many unique products based on living modified organisms does your firm have at each of the following stages?

Research & Development Stage	_____	29100
Clinical/Regulatory stage	_____	29110
Market stage	_____	29120
Total	_____	29130

b) Did your firm export living modified organisms in 2001?

29200 ☐ No

☐ Yes ► If yes, how many unique products based on living modified organisms did you export? _____ 29210
How many unique living modified organisms did you export to

United States	_____	29300
Europe	_____	29310
Other	_____	29320

Comments 30000

Thank you for your assistance.

Return the questionnaire in the accompanying self addressed prepaid envelope.

